**ARI Research Note 2009-05**

# Training Collaboration in a Network-assisted Environment

**Brooke Schaab, J. Douglas Dressel and Mark A. Sabol**
U.S. Army Research Institute

**Andrea Rittman Lassiter**
Minnesota State University
Consortium Research Fellows Program

**Organizational Performance Research Unit**
**Linda Pierce, Chief**

**January 2009**

**United States Army Research Institute**
**for the Behavioral and Social Sciences**

Approved for public release; distribution is unlimited.

**U.S. Army Research Institute**
**for the Behavioral and Social Sciences**

**A Directorate of the Department of the Army**
**Deputy Chief of Staff, G1**

**Authorized and approved for distribution:**

| | |
|---|---|
| **BARBARA A. BLACK, Ph.D.** | **MICHELLE SAMS, Ph.D.** |
| **Research Program Manager** | **Director** |
| **Training and Leader Development Division** | |

---

Technical review by

Bruce Knerr, U.S. Army Research Institute

**NOTICES**

**DISTRIBUTION:** Primary distribution of this Research Note has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Research Institute for the Behavioral and Social Sciences, Attn: DAPE-ARI-ZXM, 2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

**FINAL DISPOSITION:** This Research Note may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

**NOTE:** The findings in this Research Note are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

## REPORT DOCUMENTATION PAGE

| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED (from. . . to) |
|---|---|---|
| January 2009 | Final | June 2006 – January 2008 |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT OR GRANT NUMBER |
|---|---|
| Training Collaboration in a Network-assisted Environment | |
| | 5b. PROGRAM ELEMENT NUMBER<br>622785 |
| 6. AUTHOR(S)<br>Brooke Schaab, J. Douglas Dressel, and Mark Sabol (U.S. Army Research Institute); Andrea Rittman Lassiter (Minnesota State University) | 5c. PROJECT NUMBER<br>A790 |
| | 5d. TASK NUMBER<br>365 |
| | 5e. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>U.S. Army Research Institute for the Behavioral and Social Sciences<br>ATTN:DAPE-ARI-IOP<br>Bldg 520, Room 27<br>Aberdeen Proving Ground, MD 21005-5425 | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)<br>U.S. Army Research Institute for the Behavioral and Social Sciences<br>2511 Jefferson Davis Highway<br>Arlington, VA 22202-3926 | 10. MONITOR ACRONYM<br>ARI |
| | 11. MONITOR REPORT NUMBER<br>ARI Research Note 2009-05 |

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Subject Matter POC: Brooke Schaab

14. ABSTRACT *(Maximum 200 words)*: Technology enabled non-face-to-face collaboration has the potential to enhance information sharing and shared situational awareness (SSA) by providing near real time information to a wide audience. Collaborators require an awareness of what critical information should be shared to develop this SSA. Previous research suggested that participants, while reporting that they shared relevant information, in actuality did not. To explore this issue, the previous research was repeated with the addition of having half of the participants exposed to a short training video on how to collaborate. Participants who received training on how to collaborate located significantly more SCUDs, during each of the five turns of the two games played. Similarly, participants who received collaboration training scored higher on shared situational awareness during every turn played. Overall, those receiving the training on collaboration shared information more often with their partners and these information exchanges were longer than those who had not received the training. As technology advances, there is an increased need to understand how humans collaborate at a distance. Findings from this research advance our knowledge of how to enhance non-face-to-face collaboration.

15. SUBJECT TERMS

Spatial ability, video game, user-interface, remote control, robot

| SECURITY CLASSIFICATION OF | | | 19. LIMITATION OF ABSTRACT | 20. NUMBER OF PAGES | 21. RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| 16. REPORT | 17. ABSTRACT | 18. THIS PAGE | | | |
| Unclassified | Unclassified | Unclassified | Unlimited | 24 | Diane Hadjiosif<br>Technical Publications Specialist<br>703-602-8047 |

**ARI Research Note 2009-05**

# Training Collaboration in a Network-assisted Environment

**Brooke Schaab, J. Douglas Dressel**
**and Mark A. Sabol**
U.S. Army Research Institute

**Andrea Rittman Lassiter**
Minnesota State University
Consortium Research Fellows Program

**Organizational Performance Research Unit**
**Linda Pierce, Chief**

**January 2009**

**U.S. Army Research Institute for the Behavioral and Social Sciences**
**2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926**

**Army Project Number**
**622785A790**

**Personnel, Performance**
**and Training Technology**

Approved for public release; distribution is unlimited.

TRAINING COLLABORATION IN A NETWORK-ASSISTED ENVIRONMENT

CONTENTS



LIST OF FIGURES

# Training Collaboration in a Network-assisted Environment

## Introduction

Previous research on non-face-to-face collaboration in network-enabled environments, documented in *Performance in a distal collaborative environment* (Schaab, Dressel, Sabol, & Rittman, 2007), led researchers to question why some participants who engaged in minimal collaboration reported first, that collaboration was necessary to succeed and second, that they indeed had collaborated during the game. If participants truly thought that they had collaborated when they did not, could it be that they did not know how to collaborate effectively? Subsequent observation in an experiment comprised of a large group of former military personnel suggested a similar lack of collaboration. One retired Major General emphasized a need to "break the stovepipes" and collaborate with others to get information to those who needed it in a timely fashion. Additionally, he noted that this failure to collaborate contributed to reduced situational awareness. In order to determine if training directed on how to collaborate would enhance information sharing and improve shared situational awareness, the experiment from Schaab et al. (2007) was modified by having half of the participants exposed to a short training video on how to collaborate. Those who did not receive the training on how to collaborate were provided with an equal amount of time to explore the game. A description of the experiment follows along with a brief summary of the findings from the initial experiment (see Schaab et al., 2007 for detailed findings). Findings from the current research clearly demonstrated that collaboration training significantly improved performance.

## Research concepts

### *Research Venue*

SCUDHunt, an on-line game developed by Thoughtlink, INC (www.thoughtlink.com), was selected for this research on collaboration because it provided a simplified model of the interplay of shared awareness and collaboration, while permitting independent manipulation of variables thought to affect them. SCUDHunt required participants to (1) collaborate from distributed locations and (2) share unique information from their intelligence assets for optimal game performance. The goal of the game is simple: locate three SCUD missile launchers on a map. The game requires geographically dispersed players to collaborate while executing digital tasks in order to achieve a shared goal.

### *Cognitive Task Analysis*

A cognitive task analysis of SCUDHunt identified critical points where collaboration would be beneficial (Ross, 2003). In general, players needed to communicate planning strategies and to share gathered information in order to perform effectively. The collaboration areas identified were:

1. SEARCH- Generate own plan and coordinate plan with partner who controls other assets for asset placement in order to gain the most coverage and avoid limitations;

2. DISCUSS RESULTS- Coordinate to find out what assets were used by partner to get the results, consider the reliability of these assets, and consider any previous data and interpretations; and

3. GENERATE/COORDINATE STRIKE PLAN- Coordinate strike plan (where participants think SCUDs are located) with partner to verify its strength.

### *Common Knowledge*

This situation of networked individuals who have shared goals but unique roles and responsibilities raised the question of collaboration at a distance: to what extent does knowledge about a partner's role (all condition) influence an individual's performance effectiveness? Findings from the initial experiment (Schaab et al., 2007) revealed that during the first of the two games played, no differences in performance were seen between those trained in the all condition and those trained only on their own assets and responsibilities (own condition) in either quality score (number of SCUD launchers located) or shared-situational awareness (number of identified locations in common). In the second game, participants in the all condition located significantly more SCUD launchers than did those in the own condition, but those in the own condition had significantly higher levels of shared-situational awareness. This means that participants who were cross-trained in both their role and in their partner's role were more successful in locating SCUD launchers. Participants trained solely in their role achieved higher levels of agreement with their partner on where they thought that the SCUD launchers were located, but were wrong more frequently than those who were cross trained.

### *Communication Mode*

Communication mode was manipulated. All pairs wore headsets that allowed oral communication during one of the two games played; during the other game, participants communicated by sending typed messages via an on-screen "chat" box. For a random half of the pairs, the "chat" game came first. The data analyzed included measures of the types and frequency of communication between participants in the "chat" game. Players with a higher frequency of communications in the categories of game situation, player status, and non-task related/social, identified a significantly greater number of SCUDs. No significant difference in quality score or shared-situational awareness was found during the initial experiment as a function of communication mode, therefore text chat was used for all communication during this replication. Data on the number of messages sent and the total number of words sent were collected (Schaab et al., 2007).

## Method

### *Participants*

Sixty-four undergraduate students, 28 females and 36 males, received course credit for three hours of participation. Participants ranged in age from 18 to 45 years, with the majority, 75 percent, between 18 to 25 years. Four participants had military experience.

### *Materials*

*Questionnaire.* At the beginning of the session, participants completed a questionnaire requesting demographic information (e.g., gender, age, and military experience) and computer experience.

*Workload.* The NASA Task Load Index (TLX) (Hart & Staveland, 1988) is a multi-dimensional rating tool that provides workload scores based on six subscales: Mental Demands, Physical Demands, Temporal Demands, Own Performance, Effort, and Frustration. The NASA TLX was administered to each participant after completing each of two games of SCUDHunt.

*Game Description.* SCUDHunt is a representation of a situation in which Soldiers would use digital systems to execute tasks requiring collaboration. The SCUDHunt game presented players with the mission of determining where – on a five-by-five grid board representing the map of a hostile country – the launchers for SCUD missiles were located. Participants were told that there were three SCUD launchers, each in a different fixed location among the 25 squares on the board. On each of five turns, participants deployed intelligence-gathering assets (for example, a reconnaissance satellite or a team of Navy Seals), received reports from those assets, and created a "strike plan" (to be sent to their fictional commander) indicating their best guess based on all the information received both from that turn and previous turns as to the SCUD launcher locations. They were told that the final strike plan – after the fifth turn – would be used by their commander to direct an attack on the SCUD launchers, and they were given the results of this final strike plan in terms of which bombed location held a now-destroyed launcher. Participants controlled either air or ground assets (see Figure 1) with each asset having unique capabilities and returning intelligence reports of different reliabilities. For example, eyes on target reports from human intelligence assets would be more reliable than reports generated from satellites where sensors which must interpret images from great distances.

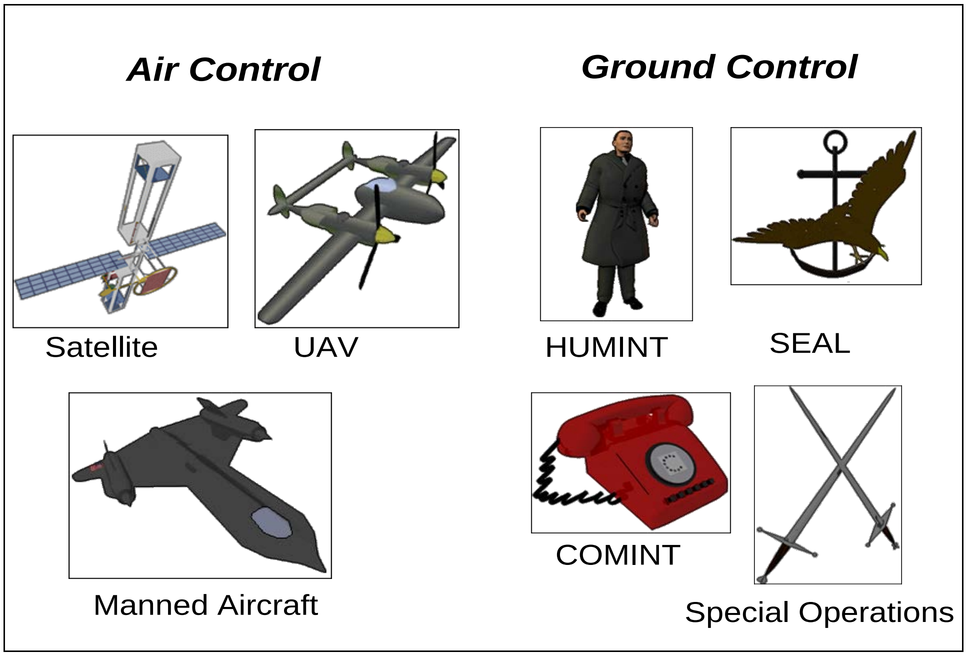



*Figure 1.* Participants controlled either air assets or ground assets.

*Measures.* Generated as the game was played were 1) the number of SCUD launcher locations correctly identified, called quality score, 2) the degree to which the two participants on a team chose the same grid squares or location in their independent strike plans, called shared-situational awareness, 3) the number of text chat communications taking place, 4) measures of subjective workload reported on the NASA TLX, and 5) responses to questionnaire items on demographics and computer experiences.

*Design.* The primary independent variable for this experiment was training on how to collaborate, with half of the participants randomly assigned to receive this training. Variable manipulations were identical to the initial experiment. Common knowledge on all versus own training conditions involved training on the characteristics of the information-gathering assets used in the SCUDHunt game (see Figure 2). Every participant received, as their first training module, an explanation of the characteristics of the assets they would be controlling. Half of the pairs (the own condition) received a second exposure to the same asset training; the other half (the all condition) received training in which each participant learned the characteristics of assets to be controlled by that participant's partner. Half of the participants in the all condition and half in the own condition received a short training segment on how to collaborate which was presented via computer to ensure consistency. Those who did not receive this training were allowed an equal amount of time to practice the game. Training consisted of fourteen Power Point slides with voice over. Participants were asked a question

followed by the answer on the subsequent slide. For example, a view of the response grid was shown with results from the initial query. Participants in the training condition were asked, “Is this a good initial plan? Why?” The following slide described why it was a good plan (initial search covered a wide area with no duplication).

| | All | Own |
|---|---|---|
| Collaboration Training | 16 | 16 |
| No Collaboration Training | 16 | 16 |

*Figure 2*. Design.

*Procedure.* Upon arrival at the laboratory, individual participants were sent to separate rooms where they read and signed a standard consent form describing the experiment and their rights as participants. This was followed by each participant completing a questionnaire on demographics and their experience with computers and computer games. Researchers then explained that the experiment involved participants playing a computer game with a partner who was located in another room.

Several computer-based training modules were then presented on 1) the overall aspects of playing the SCUDHunt game and 2) the characteristics of the information-gathering assets used in playing the game. Participants took paper and pencil quizzes on the material just presented following each training module and were given immediate corrective feedback, if necessary, to ensure that they understood how to play the game and the capabilities of their assets. Half of the participants were provided with a short training module on how to collaborate. The remaining half was given an equal amount of time to practice the game. After this training, the pair played a one-turn practice game, to ensure that the mechanics of playing the game were understood. After the experimenters answered any question the participants might have, the pair played two complete five-turn games of SCUDHunt. During these games, data were automatically collected on 1) the messages participants sent to each other, 2) the degree to which grid squares chosen as targets in the "strike plans" (submitted at the end of each turn) were identical for the two members of the pair, and 3) the number of those chosen target squares that actually contained missile launchers.

## Results

*Quality Scores.* Participants who received training on how to collaborate located more SCUDs, thereby receiving higher quality scores, during each of the five turns of both games (see Figure 3). Results from Analyses of Variance (ANOVAs) for each game show that those receiving collaboration training received significantly higher

quality scores than those who did not receive the training. ANOVA results for game 1 were $F$ (1, 62) = 6.373, $p$ <.05, eta squared = .093, and results for game 2 were $F$ (1, 61) = 7.084, $p$ <.05, eta squared = .104

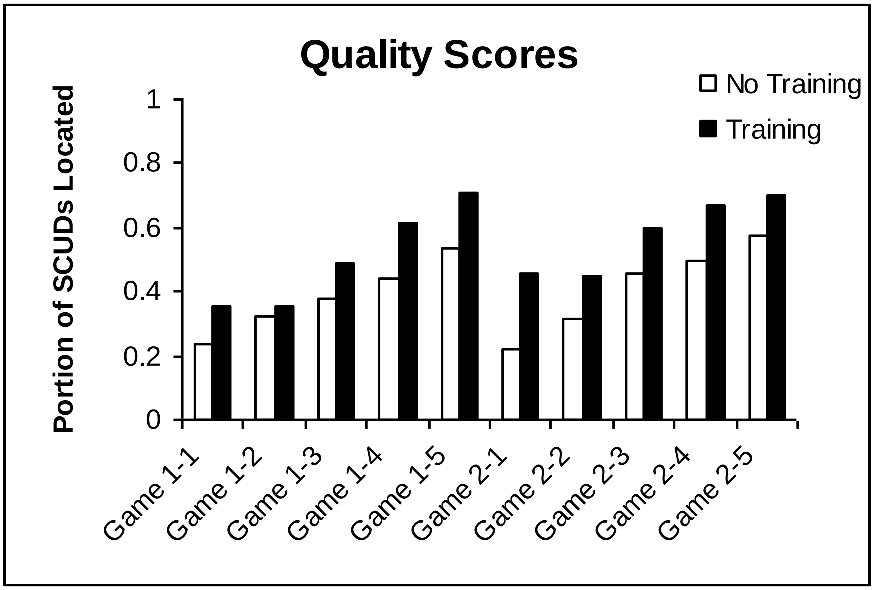



*Figure 3*. Comparison of Quality Scores between those who received training on collaboration and those who did not receive the training.

*Shared Situational Awareness.* Similarly, participants who received collaboration training scored higher on shared situational awareness during every trial (see Figure 4). ANOVA results for game 1 were $F$ (1, 62) = 14.442, $p$ <.05, eta squared = .189 and for game 2 were $F$ (1, 62) = 11.759, $p$ <.05, eta squared = .159.

*Workload.* No significant difference in workload was found between the groups who had collaboration training and those who did not.

*All and Own Training Conditions*. No significant difference was found between quality scores or shared situational awareness when comparing those who were trained in the all and the own condition. These findings differ from those found in the initial experiment. It is possible that the additional time provided both conditions (collaboration training or additional practice) may have increased participants overall proficiency in playing the game, thereby reducing the influence of training on both their own and their partners tasks.

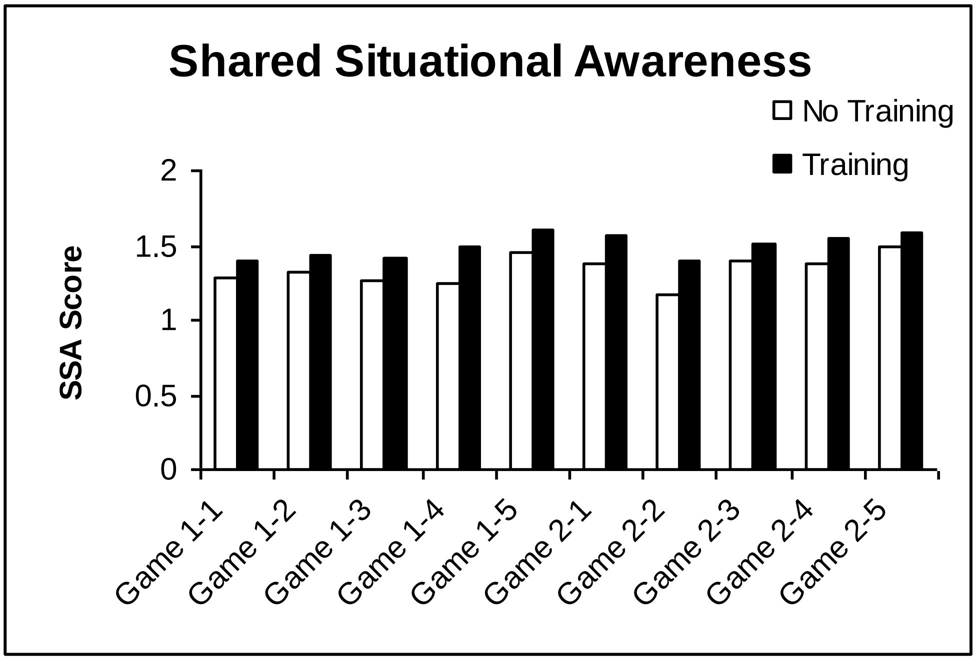



*Figure 4*. Comparison of Quality Scores between those who received training on collaboration and those who did not receive the training. No locations in common=0; All 3 locations in common=2.

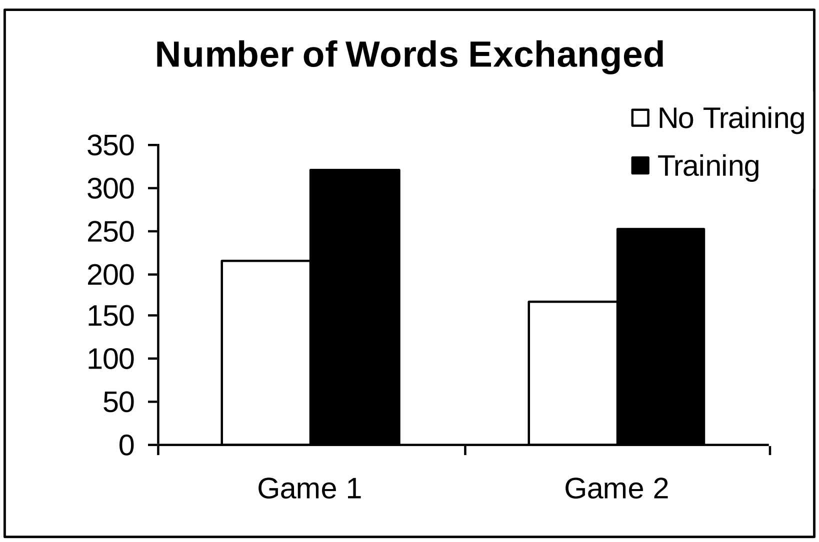



*Figure 5.* Comparison of number of words exchanged during game 1 and game 2 as a function of whether participants received collaboration training.

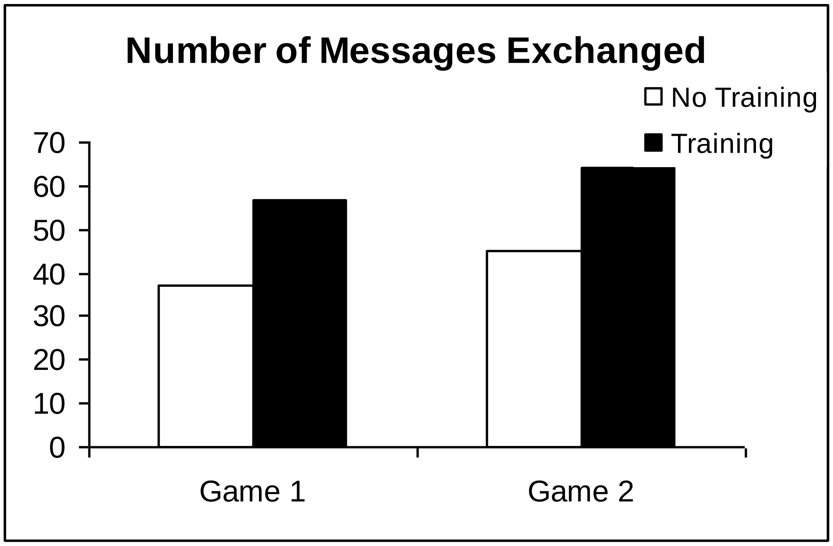



*Figure 6*. Comparison of number of messages exchanged during game 1 and game 2 as a function of whether participants received collaboration training.

*Number of Words and Messages Exchanged.* Those who received collaboration training exchanged significantly more words with their partner ($F$ (1, 62) = 5.36, $p$ < .05, eta squared = .08) and exchanged significantly more messages ($F$ (1, 62) = 4.75, $p$ < .05, eta squared = .071) than those who did not receive the collaboration training (see Figures 5 and 6).

**Discussion**

Collaboration is a commonly used but ill-defined term. Technology enables more and more non-face-to-face collaboration, with the promise of enhanced information sharing and shared-situational awareness. But technology alone is not the answer. As technology advances, there is an increased need to understand how humans collaborate at a distance. Findings from this research advance our knowledge of how to enhance non-face-to-face collaboration. Our initial research suggested that participants do not have a clear understanding of how to collaborate in non-face-to-face computer mediated environments. When participants were provided with a short training video that asked them to think about how and when they should collaborate, followed by a demonstration of collaboration on the task, their performance in locating SCUD missiles and in their shared-situational awareness improved significantly. Additionally, partners engaged in more frequent communications. These findings suggest that training on digital systems should include a segment on how to effectively use these systems to solicit, share, and combine information collaboratively.

## References

Hart, S. G. & Staveland, L. E. (1988). Development of a multi-dimensional workload rating scale: Results of empirical and theoretical research. In P. A. Hancock & N. Meshkati (Eds.), *Human Mental Workload.* Amsterdam. The Netherlands: Elsevier.

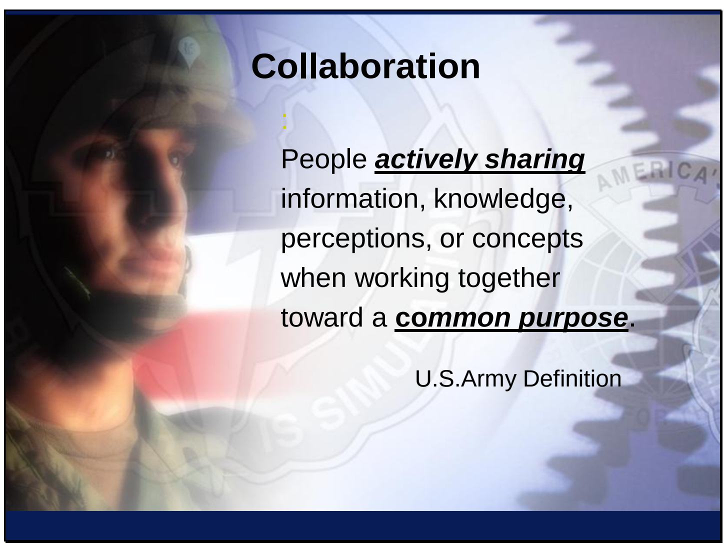
Ross, K.G. (September, 2003). Perspectives on Studying Collaboration in Distributed Networks, Contractor Report prepared for the U. S. Army Research Institute for the Behavioral and Social Sciences by Klein Associates Inc., Fairborn, Ohio, under Contract PO DASW01-02-P-0526.

Schaab, B., Dressel, J. D., Sabol, M. A., & Rittman, A.L. (2007). *Non-face-to-face Collaboration in Collaborative Information Environments* (ARI Research Report). Arlington, VA: U. S. Army Research Report for the Behavioral and Social Sciences.

**Appendix**

**Slide A1**


**Slide A2**



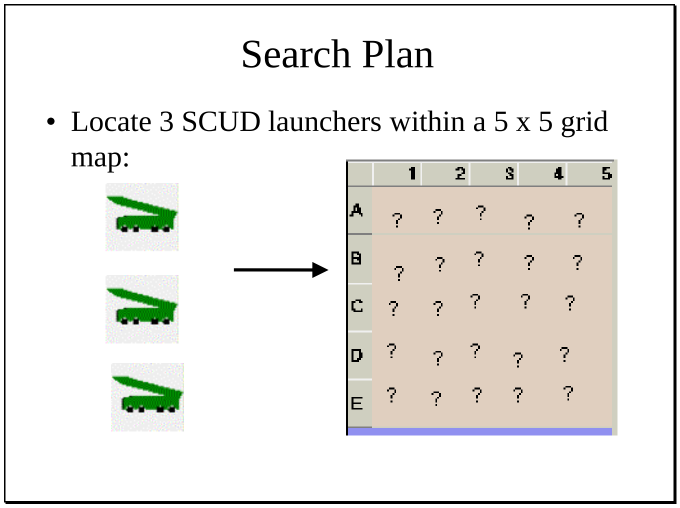

Collaboration is necessary for mission success in SCUDHunt.
The Army defines collaboration as "People **actively sharing** information, knowledge, perceptions, or concepts when working together towards a **common purpose**." Here are the areas where you need to collaborate.

**Slide A3**


**Slide A4**

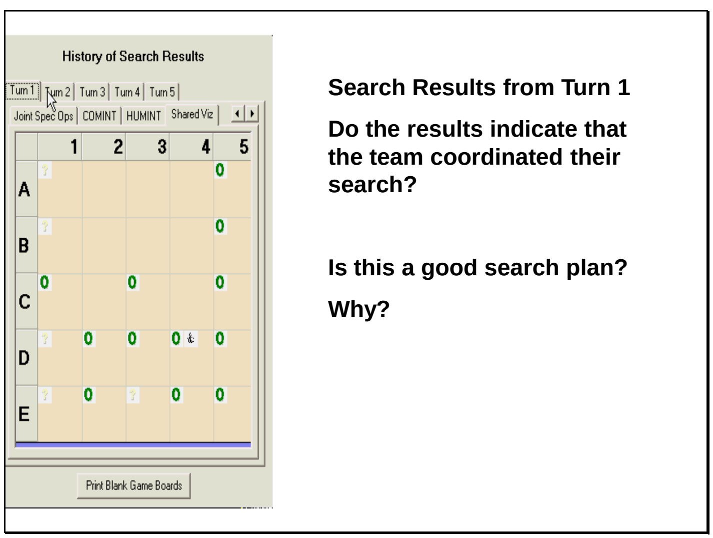

Successful collaboration improves your chances of locating the 3 Scud missile launchers in SCUDHhunt.  Coordinate with your ally to determine how to deploy your assets to cover the most territory in your searches.

**Slide A5**



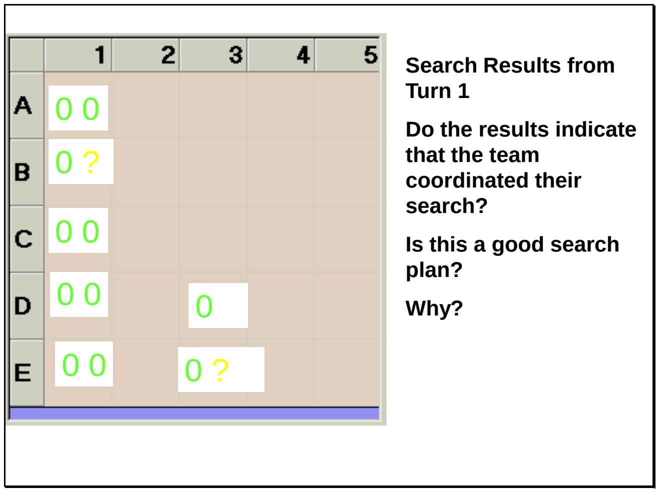

What is the best way to begin your search? *Delay going to next slide.*

**Slide A6**



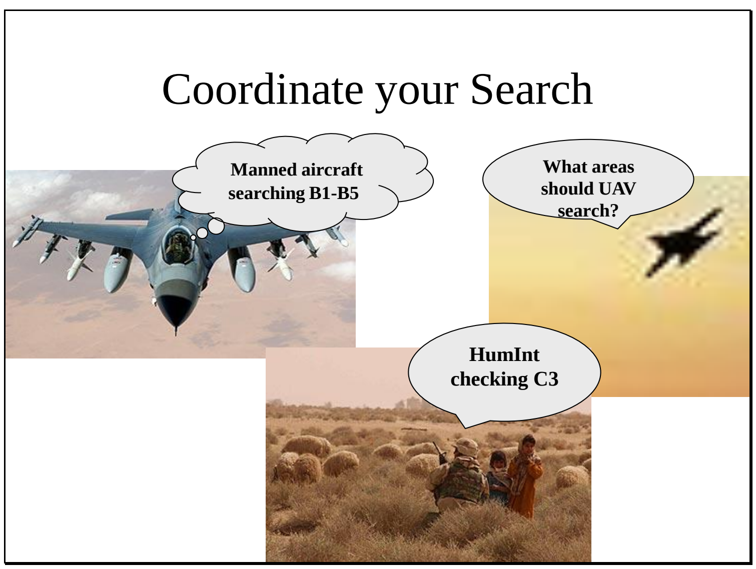

Team members deployed their intelligence assets and these are the intelligence reports from turn 1. You can see that the team coordinated their search because they maximized their coverage of the search area on this first search. There is one location where this search may not have been well coordinated. Look at location D4. It looks like 2 intelligence assets searched the same area. Because this is the first search, this may not be the best use of the assets. If this was not the first search, the assets at D4 may be rechecking a suspected area for the Scud.

**Slide A7**




Here are the intelligence reports from another team for the first search.
It looks like these team members did not coordinate because they used their intelligence resources to search the same areas. Remember, this is the first search and it is wise to gather as much information as quickly as possible. In subsequent turns you may want to take a second look at some areas based on the intelligence report and the reliability of the asset reporting.

**Slide A8**

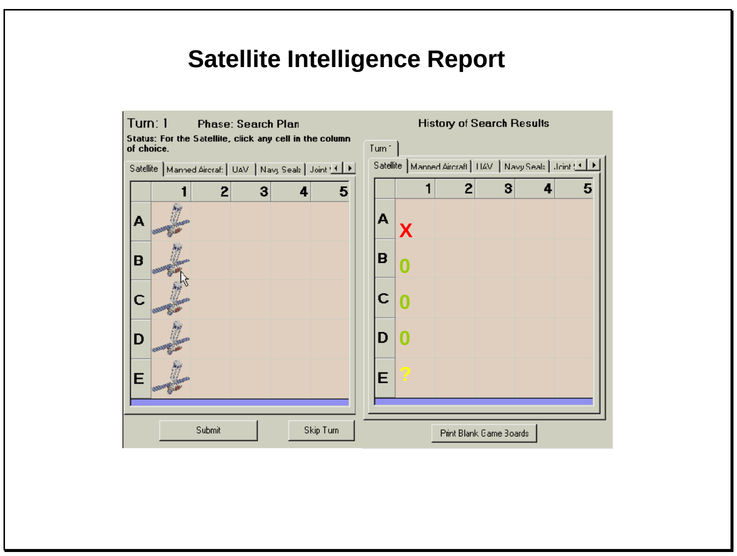



For example, coordinate your search with your ally so that you cover as much of the map area as possible. We don't have any reports from column B. I'll search that area. HumInt-I'll stay at C3 and report next turn. UAV-Is there an area that has not been searched?

**Slide A9**

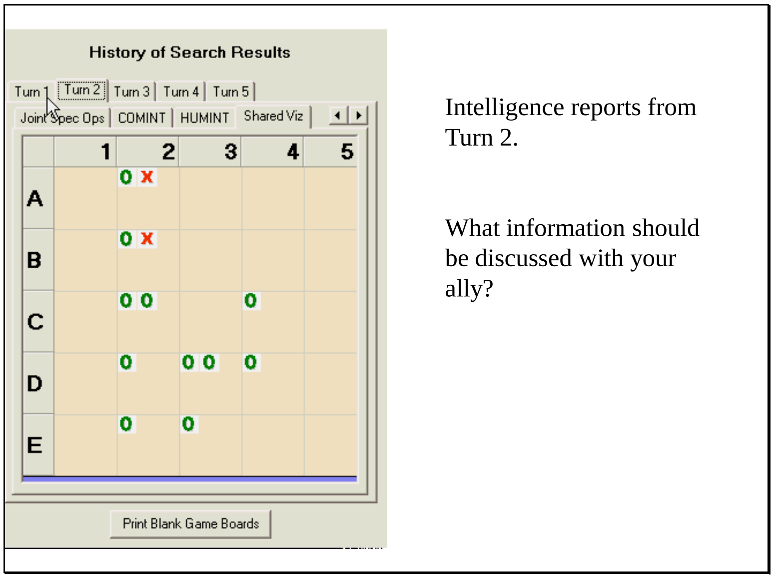

After deploying your assets, you receive intelligence reports of the results. Remember that you and your ally control different assets and the intelligence from these assets may have limited reliability. You need to share the information on the reliability of your assets with your ally to effectively interpret the results.

**Slide A10**



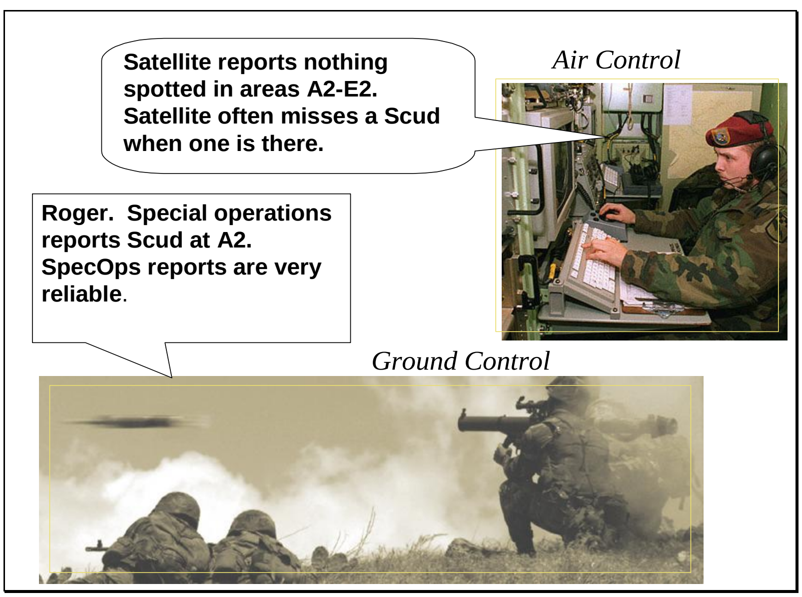

You can see the intelligence report from each of your assets by clicking on the tab of that asset on the left-hand map. The results appear on the map on the right. You will see the results one asset at a time.

**Slide A11**




The shared viz view shows you the results from all assets deployed during this turn. These are the intelligence reports from Turn 2. What does it mean? Are there really scuds located at A2 and B2? Collaborate with your ally to determine what asset reported a scud sighting. How reliable are the reports from those assets? How about the green 0 indicating nothing to report? How confident are you that there really is nothing at those locations? Again, check with your ally to determine what intelligence provided that information and discuss how reliable the report is

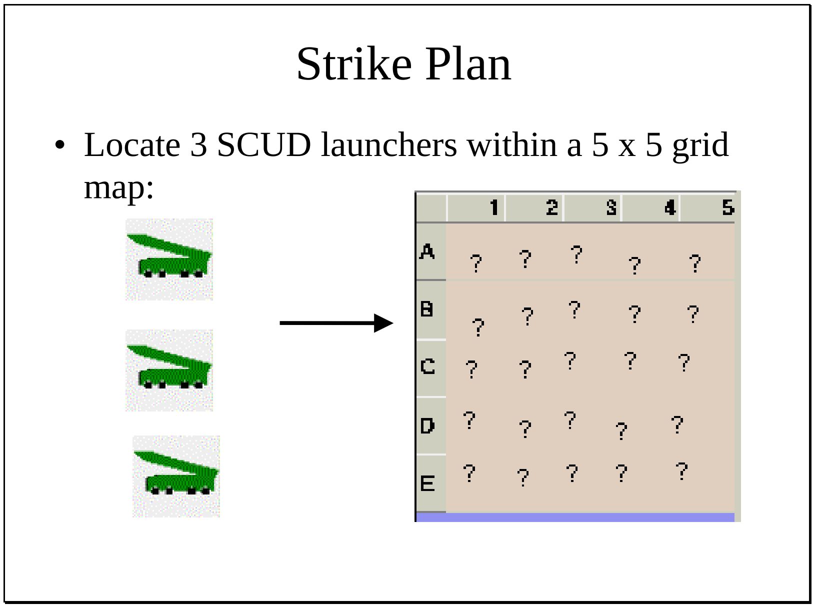
**Slide A12**



**Slide A13**

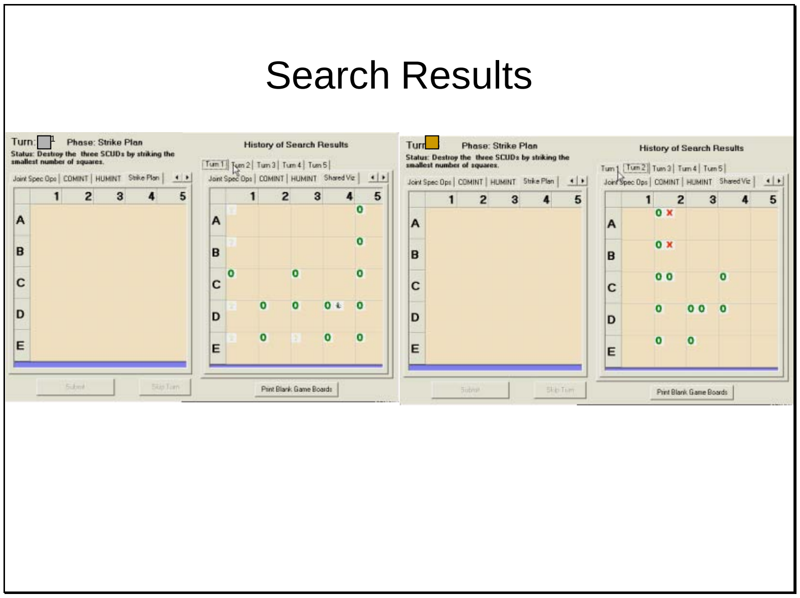

After deploying your assets, you receive intelligence reports of the results.
Remember that you and your ally control different assets and the intelligence from these assets may have limited reliability. You need to share the information on the reliability of your assets with your ally to meaningfully interpret the search results.

**Slide A14**



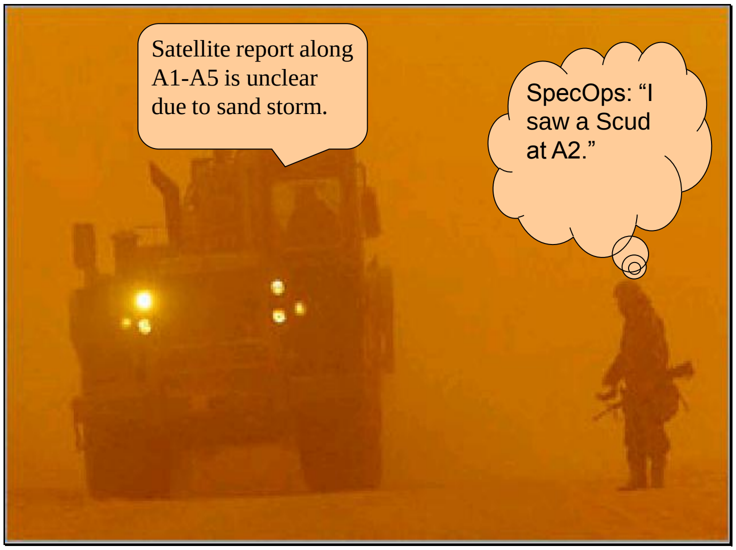

You have planned with your ally on where to deploy your combined assets and received the resulting intelligence reports from these assets. Now you must develop a Strike Plan to send to your commander. This Strike Plan tells your commander the most likely location of the 3 scuds based on the intelligence that you have at this time. Remember that the scuds do not move, therefore combine the intelligence reports from previous searches with your current search results to arrive at your best guess. Your commander does NOT want you to discuss the 3 areas that you recommend striking with your ally. Your commander wants separate interpretations of the intelligence reports from you and your ally. Therefore, you and your ally will develop your own Strike Plan.

**Slide A15**




Here are the search results from Turn 1 and Turn 2. Remember that the Scuds do not move. Based on these intelligence reports, where what Strike Plan would you recommend to your commander? You may discuss these reports with your ally. For example, you would want to know how reliable the reports are from A2 and B3 because those assets reports a Scud present. The ? Indicates some type of vehicle, possibly a Scud. How likely are those assets to report some type of vehicle if there is a Scud at that location? When you feel that you understand the intelligence reports and have some ideas on where the Scuds are located, you and your ally, on your own, select the 3 most likely areas where the Scuds could be located.

**Slide A16**




Voices.

**Slide A17**


Remember, collaborate with your ally, share what you know. You are both in this together. Good luck and good hunting!